

CLAIMS

What is claimed is:

1. A polyester resin composition having increased cross-linking capability for use in a coating composition, said resin composition comprising the reaction product of:

a first compound having a plurality of hydroxyl groups;

a carbamate compound reactive with said hydroxyl groups of said first compound and added in an amount sufficient to form a carbamated intermediary having at least one primary carbamate group available for cross-linking and having unreacted hydroxyl groups; and

a silyl compound having a terminal isocyanate group for reacting with said unreacted hydroxyl groups of said carbamated intermediary and having silylalkoxy groups available for secondary cross-linking.

2. A polyester resin composition as set forth in claim 1 wherein said silyl compound is further defined as an isocyanatoalkylalkoxysilane.

3. A polyester resin composition as set forth in claim 1 wherein said first compound is selected from the group consisting of erythritol, pentaerythritol, dipentaerythritol, glycerol, trimethylolethane, trimethylolpropane, dulcitol, threitol, and mixtures thereof.

4. A polyester resin composition as set forth in claim 1 wherein said carbamate compound is further defined as an alkyl carbamate having 1 to 20 carbon atoms in the alkyl chain.

5. A polyester resin composition as set forth in claim 1 wherein said silyl compound is selected from the group consisting of isocyanatopropyltrimethoxysilane, isocyanatopropylmethyldimethoxysilane, isocyanatopropylmethyldiethoxysilane, isocyanatopropyltriethoxysilane, isocyanatoneohexyltrimethoxysilane, isocyanatoneohexyldimethoxysilane, isocyanatoneohexydiethoxysilane, isocyanatoneohexyltriethoxysilane, isocyanatoisoamyltrimethoxysilane, isocyanatoisoamylmethyldimethoxysilane, isocyanatoisoamylmethyldiethoxysilane, isocyanatoisoamyltriethoxysilane, and mixtures thereof.

6. A polyester resin composition as set forth in claim 1 having a polydispersity of from about 1 to about 2.

7. A polyester resin composition as set forth in claim 1 having a number-average molecular weight of less than 4000.

8. A polyester resin composition as set forth in claim 1 having a non-volatile content of from 50 to 90.

9. A polyester resin composition as set forth in claim 1 wherein said first compound is present in an amount of from 1 to 50 parts by weight based on 100 parts by weight of said polyester resin composition.

10. A polyester resin composition as set forth in claim 1 wherein said amount of said carbamate compound is from 5 to 65 parts by weight based on 100 parts by weight of said polyester resin composition.

11. A polyester resin composition as set forth in claim 1 wherein said silyl compound is present in an amount of from 1 to 70 parts by weight based on 100 parts by weight of said polyester resin composition.

12. A polyester resin composition as set forth in claim 1 further comprising a carboxylic acid anhydride reactive with said hydroxyl groups of said first compound.

13. A polyester resin composition as set forth in claim 12 further comprising a second compound having at least one epoxy group reactive with said carboxylic acid anhydride.

14. A polyester resin composition having increased cross-linking capability for use in a coating composition, said resin composition comprising the reaction product of:

a first compound having a plurality of hydroxyl groups;

a carboxylic acid anhydride;

a second compound having at least one epoxy group;

a carbamate compound; and

a silyl compound having a terminal group reactive with hydroxyl groups and having silylalkoxy groups.

15. A polyester resin composition as set forth in claim 14 wherein said first compound comprises pentaerythritol.

16. A polyester resin composition as set forth in claim 15 wherein said carboxylic acid anhydride comprises hexahydrophthalic anhydride.

17. A polyester resin composition as set forth in claim 16 wherein said second compound comprises glycidylneodecanoate.

18. A polyester resin composition as set forth in claim 17 wherein said carbamate compound comprises methyl carbamate.

19. A polyester resin composition as set forth in claim 18 wherein said silyl compound comprises an isocyanatoalkylalkoxysilane.

20. A polyester resin composition as set forth in claim 14 wherein said first compound is selected from the group consisting of erythritol, pentaerythritol, dipentaerythritol, glycerol, trimethylolethane, trimethylolpropane, dulcitol, threitol, and mixtures thereof.

21. A polyester resin composition as set forth in claim 14 wherein said second compound is selected from the group consisting of glycidylneodecanoate, dodecyl oxide, tetradecyl oxide, octadecyl oxide, and cyclohexene oxide, and mixtures thereof.

22. A polyester resin composition as set forth in claim 14 wherein said carboxylic acid anhydride is selected from the group consisting of maleic anhydride, hexahydrophthalic anhydride, methyl-hexahydrophthalic anhydride, tetrahydrophthalic anhydride, phthalic anhydride, succinic anhydride, dodecenylsuccinic anhydride, trimellitic anhydride, and mixtures thereof.

23. A polyester resin composition as set forth in claim 14 wherein said carbamate compound is further defined as an alkyl carbamate having 1 to 20 carbon atoms in the alkyl chain.

24. A polyester resin composition as set forth in claim 14 wherein said carbamate compound is selected from the group consisting of methyl carbamate, ethyl carbamate, and mixtures thereof.

25. A polyester resin composition as set forth in claim 14 wherein said silyl compound is selected from the group consisting of isocyanatopropyltrimethoxysilane, iso-cyanatepropylmethyldimethoxysilane, isocyanatopropylmethyldiethoxysilane,

isocyanate-propyltriethoxysilane, isocyanatoneohexyltrimethoxysilane, isocyanateneohexyldimethoxysilane, isocyanatoneohexyldiethoxysilane, isocyanatoneohexyltriethoxysilane, isocyanateisoamyltrimethoxysilane, isocyanatoisoamyltrimethoxysilane, isocyanatoisoamylmethyldiethoxysilane, isocyanatoisoamyltriethoxysilane, and mixtures thereof.

26. A polyester resin composition as set forth in claim 14 having a polydispersity of from about 1 to about 2.

27. A polyester resin composition as set forth in claim 14 having a number average molecular weight of less than 4000.

28. A polyester resin composition as set forth in claim 14 having a non-volatile content of from 50 to 90.

29. A polyester resin composition as set forth in claim 14 wherein said first compound is present in an amount from 1 to 50 parts by weight based on 100 parts by weight of said polyester resin composition.

30. A polyester resin composition as set forth in claim 14 wherein said carboxylic acid anhydride is present in an amount from 10 to 40 parts by weight based on 100 parts by weight of said polyester resin composition.

31. A polyester resin composition as set forth in claim 14 wherein said second compound is present in an amount from 20 to 70 parts by weight based on 100 parts by weight of said polyester resin composition.

32. A polyester resin composition as set forth in claim 14 wherein said amount of said carbamate compound is from 5 to 65 parts by weight based on 100 parts by weight of said polyester resin composition.

33. A polyester resin composition as set forth in claim 14 wherein said silyl compound is added in an amount of from 1 to 70 parts by weight based on 100 parts by weight of said polyester resin composition.

34. A method of preparing a polyester resin composition for use in a coating composition, said method comprising the steps of:

- (A) providing a branched compound having a plurality of hydroxyl groups;
- (B) reacting hydroxyl groups with a carbamate compound to form a carbamated intermediary having at least one primary carbamate group available for cross-linking and having unreacted hydroxyl groups;
- (C) reacting the unreacted hydroxyl groups of the carbamated intermediary with a silyl compound having a terminal group reactive with said unreacted hydroxyl groups and having silylalkoxy groups, each being available for cross-linking, to form the resin composition.

35. A method as set forth in claim 34 wherein the step of (A) providing the branched compound is further defined as providing a first compound selected from the group consisting of erythritol, pentaerythritol, dipentaerythritol, glycerol, trimethylolethane, trimethylolpropane, dulcitol, threitol, and mixtures thereof.

36. A method as set forth in claim 34 further comprising the step of reacting the hydroxyl groups of the branched compound with a carboxylic acid anhydride selected from the group consisting of maleic anhydride, hexahydrophthalic anhydride, methylhexahydrophthalic anhydride, tetrahydrophthalic anhydride, phthalic anhydride, succinic anhydride, dodecenylsuccinic anhydride, trimellitic anhydride, and mixtures thereof, to

form a first intermediate compound having the plurality of carboxylic acid groups prior to reacting with the carbamate compound.

37. A method as set forth in claim 36 further comprising the step of reacting at least one of the carboxylic acid groups of the first intermediate compound with a second compound selected from the group consisting of glycidylneodecanoate, dodecyl oxide, tetradecyl oxide, octadecyl oxide, and cyclohexene oxide, and mixtures thereof, to form the second intermediate compound having the at least one hydroxyl group prior to reacting with the carbamate compound.

38. A method as set forth in claim 37 further comprising the the step of reacting the at least one hydroxyl group of the second intermediate compound with an alkyl carbamate having from 1 to 20 carbon atoms in the alkyl chain, to prepare the resin composition of step (B).

39. A method as set forth in claim 38 wherein the step of (C) reacting any remaining hydroxyl groups of the carbamated intermediary with the silyl compound is further defined as reacting any remaining hydroxyl groups of the carbamated intermediary with at least one of isocyanatopropyltrimethoxysilane, isocyanatopropylmethyldimethoxysilane, isocyanatopropylmethyldiethoxysilane, isocyanatopropyltriethoxysilane, isocyanatoneohexyltrimethoxysilane, isocyanatoneohexyldimethoxysilane, isocyanatoneohexyldiethoxysilane, isocyanatoneohexyltriethoxysilane, isocyanate-isoamyltrimethoxysilane, isocyanatoisoamylmethyldimethoxysilane, isocyanatoisoamylmethyldiethoxysilane, and isocyanatoisoamyltriethoxysilane.

40. A method as set forth in claim 34 further including the step of continuing the reaction of step (C) until less than 5% of isocyanate groups remain in the resin composition.

41. A method as set forth in claim 40 further including the step of removing excess carbamate compound that has not reacted with the hydroxyl groups.

42. A method as set forth in claim 34 wherein the steps of (A) through (C) are conducted at a temperature between 50°C and 200°C.